(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 May 2001 (31.05.2001)

PCT

(10) International Publication Number
WO 01/38716 A1

(51) International Patent Classification[7]: F02M 25/08

(21) International Application Number: PCT/CA00/01368

(22) International Filing Date: 17 November 2000 (17.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/166,404 19 November 1999 (19.11.1999) US
09/542,052 31 March 2000 (31.03.2000) US

(71) Applicant: SIEMENS CANADA LIMITED [CA/CA]; 2185 Derry Road West, Mississauga, Ontario L5N 7A6 (CA).

(72) Inventors: COOK, John, Edward; 17 Kingsway Drive, Chatham, Ontario N7L 2S8 (CA). PERRY, Paul, Douglas; 82 Gladstone Avenue, Chatham, Ontario N7L 2C3 (CA).

(74) Agent: MACRAE & CO.; P.O. Box 806, Station B, Ottawa, Ontario K1P 5T4 (CA).

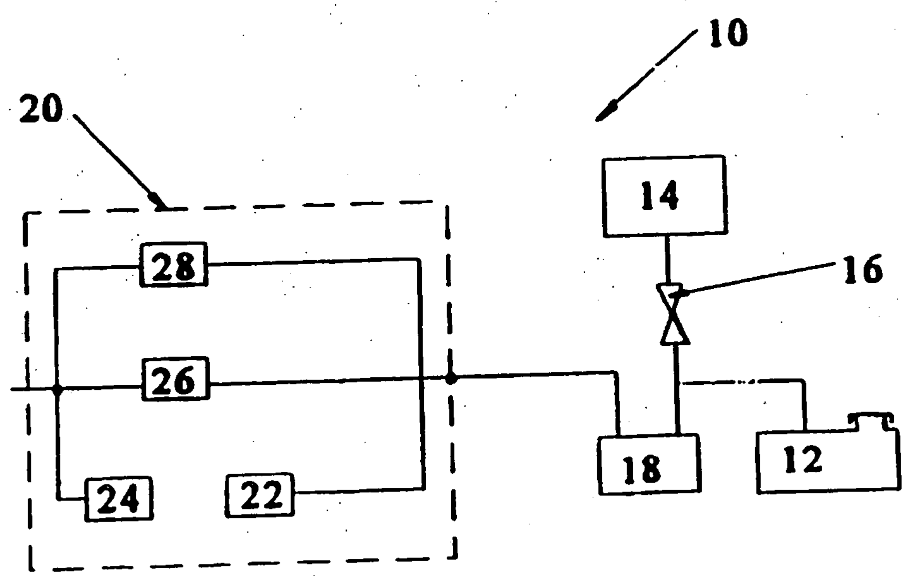
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INTEGRATED PRESSURE MANAGEMENT SYSTEM FOR A FUEL SYSTEM



(57) Abstract: An integrated pressure management system (20) manages pressure and detects leaks in a fuel system. The integrated pressure management system also performs a leak diagnostic for the head space in a fuel tank (12), a canister (18) that collects

WO 01/38716 A1

INTEGRATED PRESSURE MANAGEMENT SYSTEM FOR A FUEL SYSTEM

Field of Invention

The present invention relates to an integrated pressure management system that manages pressure and detects leaks in a fuel system. The present invention also relates to an integrated pressure management system that performs a leak diagnostic for the head space in a fuel tank, a canister that collects volatile fuel vapors from the head space, a purge valve, and all associated hoses.

Background of Invention

In a conventional pressure management system for a vehicle, fuel vapor that escapes from a fuel tank is stored in a canister. If there is a leak in the fuel tank, canister or any other component of the vapor handling system, some fuel vapor could exit through the leak to escape into the atmosphere instead of being stored in the canister. Thus, it is desirable to detect leaks.

In such conventional pressure management systems, excess fuel vapor accumulates immediately after engine shut-down, thereby creating a positive pressure in the fuel vapor management system. Thus, it is desirable to vent, or Ablow-off,≅ this excess fuel vapor and to facilitate vacuum generation in the fuel vapor management system. Similarly, it is desirable to relieve positive pressure during tank refueling by allowing air to exit the tank at high flow rates. This is commonly referred to as onboard refueling vapor recovery (ORVR).

Summary of the Invention

According to the present invention, a sensor or switch signals that a predetermined pressure exists. In particular, the sensor/switch signals that a predetermined vacuum exists. As it is used herein, Apressure≅ is measured relative to the ambient atmospheric pressure. Thus, positive pressure refers to pressure greater than the ambient atmospheric pressure and negative pressure, or Avacuum,≅ refers to pressure less than the ambient atmospheric pressure.

A valve can provide relief for positive pressure above a first predetermined pressure value, and can provide relief for vacuum below a second predetermined pressure value.

A solenoid can displace the valve to an open configuration for vacuum monitoring during natural cooling, e.g., after an engine is turned off, and thereby perform a leak detection diagnostic. The solenoid can also be actuated while the engine is on to confirm purge flow and switch/sensor function. Additionally, vacuum relief by the valve can provide fail-safe operation of the purge flow system in the event that the solenoid fails with the valve in a closed configuration.

The sensor/switch, the valve, and the solenoid can be integrally packaged in a single unit to improve system integrity since there are fewer leak points, i.e., possible openings in the system, and fewer electrical connectors as compared to conventional systems.

Brief Description of the Drawings

The accompanying drawings, which are incorporated herein and constitute part of this specification, illustrate the present invention, and, together with the general description given above and the detailed description given below, serve to explain features of the invention. Like reference numerals are used to identify similar features.

Figure 1 is a schematic illustration showing the operation of an apparatus according to the present invention.

Figure 2 is a cross-sectional view of a first embodiment of the apparatus according to the present invention

Figure 3 is a cross-sectional view of a second embodiment of the apparatus according to the present invention.

Detailed Description of the Preferred Embodiment

Referring to Figure 1, a fuel system 10, e.g., for an engine (not shown), includes a fuel tank 12, a vacuum source 14 such as an intake manifold of the engine, a purge valve 16, a charcoal canister 18, and an integrated pressure management system (IPMA) 20.

The IPMA 20 performs a plurality of functions including signaling 22 that a first predetermined pressure (vacuum) level exists, relieving pressure 24 at a value below the first predetermined pressure level, relieving pressure 26 above a second pressure level, and controllably connecting 28 the charcoal canister 18 to the ambient atmospheric pressure A.

In the course of cooling that is experienced by the fuel system 10, e.g., after the engine is turned off, a vacuum is created in the charcoal canister 18. The existence of a vacuum at the first predetermined pressure level indicates that the integrity of the fuel system 10 is satisfactory. Thus, signaling 22 is used for detecting leaks. Subsequently relieving pressure 24 at a value below the first predetermined pressure level protects the integrity of the fuel tank 12.

Immediately after the engine is turned off, relieving pressure 26 allows excess fuel vapor to Ablow off, thereby facilitating the desired vacuum generation that occurs during cooling. Similarly, in the course of refueling the fuel tank 12, relieving pressure 26 allows air to exit the fuel tank 12 at high flow.

While the engine is turned on, controllably connecting 28 the canister 18 to the ambient air A allows confirmation of the purge flow and allows confirmation of the signaling 22 performance. While the engine is turned off, controllably connecting 28 allows a computer for the engine to monitor the vacuum generated during cooling.

Figure 2, shows a first embodiment of the IPMA 20 mounted on the charcoal canister 18. The IPMA 20 includes a housing 30 that can be mounted to the body of the charcoal canister 18 by a Abayonet≅ style attachment 32. A seal 34 is interposed between the charcoal canister 18 and the IPMA 20. This attachment 32, in combination with a snap finger 36, allows the IPMA 20 to be readily serviced in the field. As will be described in greater detail below, the housing 30 can be assembled from three housing pieces 30a,30b,30c.

Signaling 22 occurs when vacuum at the first predetermined pressure level is present in the charcoal canister 18. A pressure operable device 36 separates an interior chamber in the housing 30. The pressure operable device 36, which includes a diaphragm 38 that is operatively interconnected to a valve 40, separates the interior chamber of the housing 30 into an upper portion 42 and a lower portion 44. The upper portion 42 is in fluid communication with the ambient atmospheric pressure through a first port 46. The lower portion 44 is in fluid communication with a second port 48 between housing 30 the charcoal canister 18. The lower portion 44 is also in fluid communicating with a separate portion 44a via first and second signal passageways 50,52. The present inventors have discovered that orienting the opening of the first signal passageway toward the charcoal canister 18 yields unexpected advantages in providing fluid communication between the portions 44,44a. Sealing between

the housing pieces 30a,30b for the second signal passageway 52 can be provided by a protrusion 38a of the diaphragm 38 that is penetrated by the second signal passageway 52. A branch 52a provides fluid communication, over the seal bead of the diaphragm 38, with the separate portion 44a. A rubber plug 30a is installed after the housing portion 30a is molded. The force created as a result of vacuum in the separate portion 44a causes the diaphragm 38 to be displaced toward the housing part 30b. This displacement is opposed by a resilient element 54, e.g, a leaf spring. The bias of the resilient element 54 can be adjusted by a calibrating screw 56 such that a desired level of vacuum, e.g., one inch of water, will depress a switch 58 that can be mounted on a printed circuit board 60. In turn, the printed circuit board is electrically connected via an intermediate lead frame 62 to an outlet terminal 64 supported by the housing part 30c. The intermediate lead frame 62 can also penetrate a protrusion 38b of the diaphragm 38 similar to the penetration of protrusion 38a by the second signal passageway 52. The housing part 30c is sealed with respect to the housing parts 30a,30b by an O-ring 66. As vacuum is released, i.e., the pressure in the portions 44,44a rises, the resilient element 54 pushes the diaphragm 38 away from the switch 58, whereby the switch 58 resets.

Pressure relieving 24 occurs as vacuum in the portions 44,44a increases, i.e., the pressure decreases below the calibration level for actuating the switch 58. Vacuum in the charcoal canister 18 and the lower portion 44 will continually act on the valve 40 inasmuch as the upper portion 42 is always at or near the ambient atmospheric pressure A. At some value of vacuum below the first predetermined level, e.g., six inches of water, this vacuum will overcome the opposing force of a second resilient element 68 and displace the valve 40 away from a lip seal 70. This displacement will open the valve 40 from its closed configuration, thus allowing air to be drawn from the upper portion 42 into the lower the portion 44. That is to say, in an open configuration of the valve 40, the first and second ports 46,48. In this way, vacuum in the fuel system 10 can be regulated.

Controllably connecting 28 to similarly displace the valve 40 from its closed configuration to its open configuration can be provided by a solenoid 72. At rest, the second resilient element 68 displaces the valve 40 to its closed configuration. A ferrous armature 74, which can be fixed to the valve 40, can have a tapered tip that creates higher flux densities and therefore higher pull-in forces. A coil 76 surrounds a solid ferrous core 78 that is isolated

from the charcoal canister 18 by an O-ring 80. The flux path is completed by a ferrous strap 82 that serves to focus the flux back towards the armature 74. When the coil 76 is energized, the resultant flux pulls the valve 40 toward the core 78. The armature 74 can be prevented from touching the core 78 by a tube 84 that sits inside the second resilient element 68, thereby preventing magnetic lock-up. Since very little electrical power is required for the solenoid 72 to maintain the valve 40 in its open configuration, the power can be reduced to as little as 10% of the original power by pulse-width modulation. When electrical power is removed from the coil 76, the second resilient element 68 pushes the armature 74 and the valve 40 to the normally closed configuration of the valve 40.

Relieving pressure 26 is provided when there is a positive pressure in the lower portion 44, e.g., when the tank 12 is being refueled. Specifically, the valve 40 is displaced to its open configuration to provide a very low restriction path for escaping vapors from the tank 12. When the charcoal canister 18, and hence the lower portions 44, experience positive pressure above ambient atmospheric pressure, the first and second signal passageways 50,52 communicate this positive pressure to the separate portion 44a. In turn, this positive pressure displaces the diaphragm 38 downward toward the valve 40. A diaphragm pin 39 transfers the displacement of the diaphragm 38 to the valve 40, thereby displacing the valve 40 to its open configuration with respect to the lip seal 70. Thus, the refueling pressure is allowed to escape from the charcoal canister 18, through the lower portion 44, past the lip seal 70, through the upper portion 42, and through the second port 58.

Relieving pressure 26 is also useful for regulating the pressure in fuel tank 12 during any situation in which the engine is turned off. By limiting the amount of positive pressure in the fuel tank 12, the cool-down vacuum effect will take place sooner.

Figure 3 shows a second embodiment of the present invention that is substantially similar to the first embodiment shown in Figure 2, except that the first and second signal passageways 50,52 have been eliminated. Instead, the signal from the lower portion 44 is communicated to the separate portion 44a via a path that extends through spaces between the solenoid 72 and the housing 30, and through spaces between the intermediate lead frame 62 and the housing 30.

While the invention has been disclosed with reference to certain preferred embodiments, numerous modifications, alterations, and changes to the described

embodiments are possible without departing from the sphere and scope of the invention, as defined in the appended claims and their equivalents thereof. Accordingly, it is intended that the invention not be limited to the described embodiments, but that it have the full scope defined by the language of the following claims.

What we claim is:

1. An integrated pressure management apparatus comprising:

a housing including an interior chamber, a first port, and a second port;

a pressure operable device separating the chamber into a first portion and a second portion, the first portion communicating with the first port, the second port communicating with the second port, the device permitting communication between the first and second ports in one configuration and inhibiting communication between the first and second ports in a second configuration; and

a switch signaling displacement of the device in response to vacuum in the first portion.

2. The integrated pressure management apparatus according to claim 1, wherein the switch is disposed in the housing.

3. The integrated pressure management apparatus according to claim 2, wherein the switch is disposed in the first portion.

4. The integrated pressure management apparatus according to claim 1, further comprising:

a solenoid displacing the device from the first configuration to the second configuration.

5. The integrated pressure management apparatus according to claim 4, wherein the solenoid includes an elongated ferrous core extending transversely with respect to a displacement direction of the device between the first and second configurations.

6. The integrated pressure management apparatus according to claim 1, further comprising:

a first resilient element opposing the displacement of the device in response to vacuum in the first portion.

7. The integrated pressure management apparatus according to claim 6, further comprising:

an adjuster calibrating a biasing force of the first resilient element.

8. The integrated pressure management apparatus according to claim 1, further comprising:

a second resilient element opposing displacement of the device from the first configuration to the second configuration.

9. The integrated pressure management apparatus according to claim 8, wherein a biasing force of the second resilient element is greater than a biasing force of the vacuum in the first portion displacing the device.

10. The leak detection apparatus according to claim 7, wherein the first portion communicates with the first port via a passage defined at least in part by a space between the housing and the solenoid.

11. The leak detection apparatus according to claim 1, wherein the first portion communicates with the first port via a passage defined at least in part by a space between the housing and electrical connections to the switch.

12. The leak detection apparatus according to claim 1, wherein the first portion communicates with the first port via a passage defined by the housing.

13. The integrated pressure management apparatus according to claim 8, further comprising:

a solenoid displacing the valve from the first configuration to the second configuration.

14. The leak detection apparatus according to claim 13, wherein the solenoid includes an elongated ferrous core extending transversely with respect to a displacement direction of the valve between the first and second configurations.

15. The integrated pressure management apparatus according to claim 14, further comprising:

a ferrous armature secured to the valve, the ferrous armature being displaced in the displacement direction by the ferrous core.

16. A method of using fluid volume variations for leak detection, the method comprising:

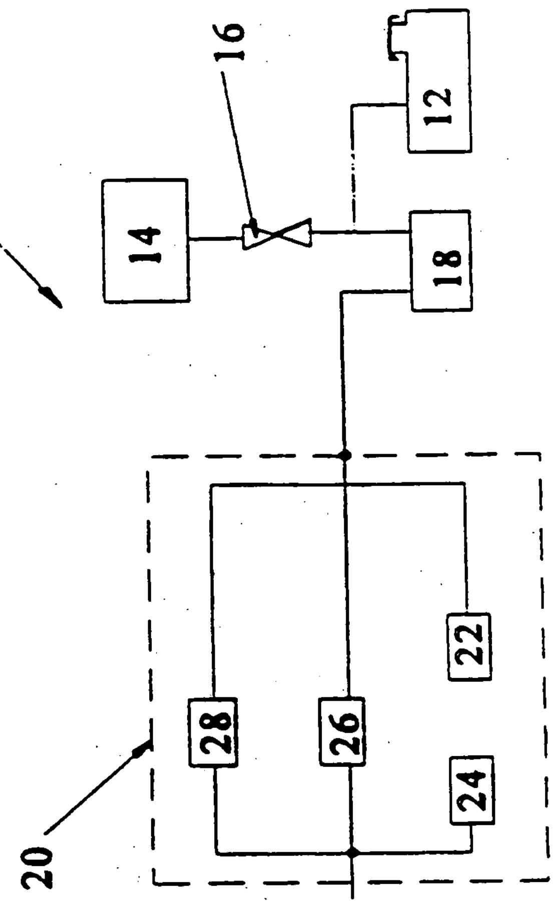
an actuator displacing the device.

17. The leak detection apparatus according to claim 2, wherein the actuator includes a solenoid.

18. The leak detection apparatus according to claim 3, wherein the detector includes a ferrous armature

being disposed on the housing and signals] in response to displacement of the device in the chamber.

Fig. 1



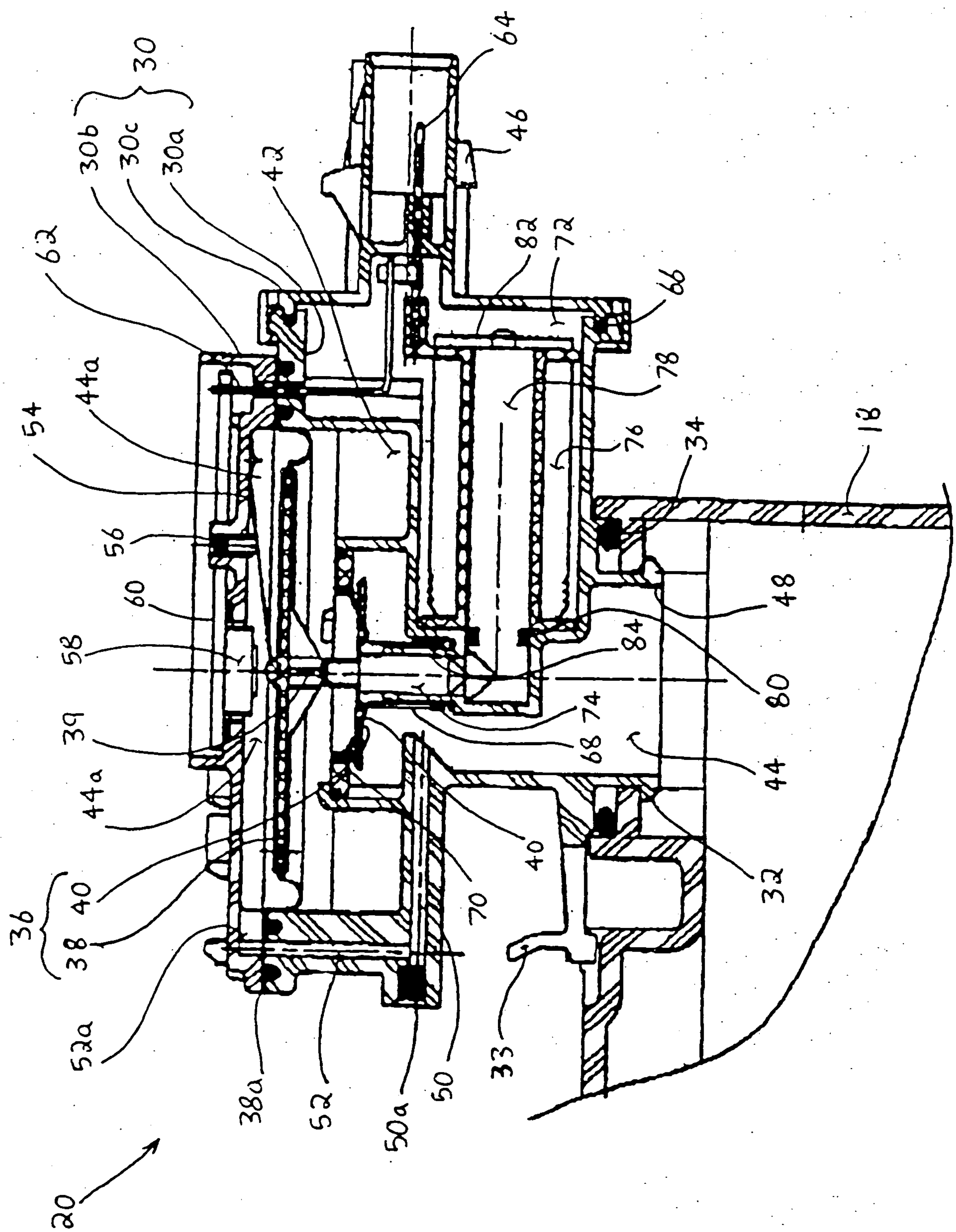

30
30b
30c
30a
62
43
64
46
82
72
66
78
76
34
18
54
44a
56
60
58
39
44a
36
38
40
52a
38a
52
50a
50
33
70
40
32
44
68
74
84
80
48
20

FIG. 2

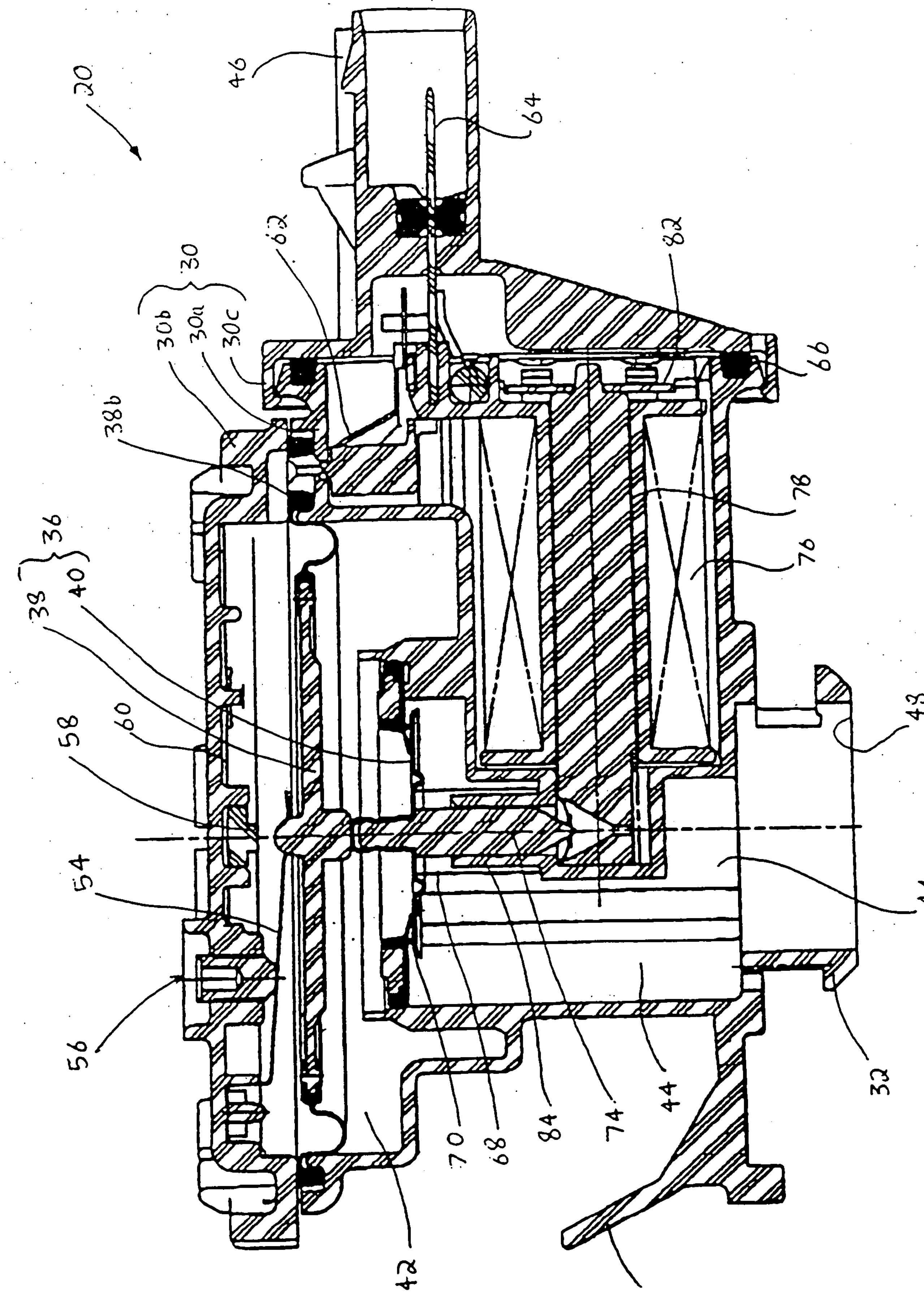

20
46
64
62
82
30
30b
30a
30c
38b
36
38
40
58
60
54
56
42
70
68
84
74
44
44
32
43
44
66
78
76

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 00/01368

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02M25/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 474 050 A (COOK JOHN E ET AL) 12 December 1995 (1995-12-12) column 6, line 46 -column 8, line 20; figures	1,13
A	EP 0 688 691 A (BOSCH GMBH ROBERT) 27 December 1995 (1995-12-27) abstract; figures 1,2	1,13
A	US 5 635 630 A (BUSATO MURRAY ET AL) 3 June 1997 (1997-06-03) abstract; figures	1,13
A	WO 99 50551 A (SIEMENS CANADA LTD) 7 October 1999 (1999-10-07)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search: 13 March 2001

Date of mailing of the international search report: 19/03/2001

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL – 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer
Sideris, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/CA 00/01368

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5474050 A	12-12-1995	WO 9621805 A	18-07-1996
		CN 1168167 A	17-12-1997
		DE 69601920 D	06-05-1999
		DE 69601920 T	09-09-1999
		EP 0803025 A	29-10-1997
		JP 10512344 T	24-11-1998
EP 0688691 A	27-12-1995	DE 4420960 A	21-12-1995
		DE 59501589 D	16-04-1998
		JP 8100768 A	16-04-1996
		US 6059543 A	09-05-2000
US 5635630 A	03-06-1997	US 5383437 A	24-01-1995
		AU 6914794 A	12-12-1994
		CA 2162862 A	24-11-1994
		EP 0707709 A	24-04-1996
		WO 9427131 A	24-11-1994
		US 5495749 A	05-03-1996
		WO 9415090 A	07-07-1994
		DE 69325041 D	24-06-1999
		DE 69325041 T	21-10-1999
		EP 0774064 A	21-05-1997
		JP 8505197 T	04-06-1996
WO 9950551 A	07-10-1999	BR 9909135 A	05-12-2000
		EP 1066461 A	10-01-2001

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 May 2001 (31.05.2001)

PCT

(10) International Publication Number
WO 01/38716 A1

(51) International Patent Classification[7]: F02M 25/08

(21) International Application Number: PCT/CA00/01368

(22) International Filing Date: 17 November 2000 (17.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/166,404 19 November 1999 (19.11.1999) US
09/542.052 31 March 2000 (31.03.2000) US

(71) Applicant: SIEMENS AUTOMOTIVE INC. [CA/CA]; 2185 Derry Road West, Mississauga, Ontario L5N 7A6 (CA).

(72) Inventors: COOK, John, Edward; 17 Kingsway Drive, Chatham, Ontario N7L 2S8 (CA). PERRY, Paul, Douglas; 82 Gladstone Avenue, Chatham, Ontario N7L 2C3 (CA).

(74) Agent: MACRAE & CO.; P.O. Box 806, Station B, Ottawa, Ontario K1P 5T4 (CA).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

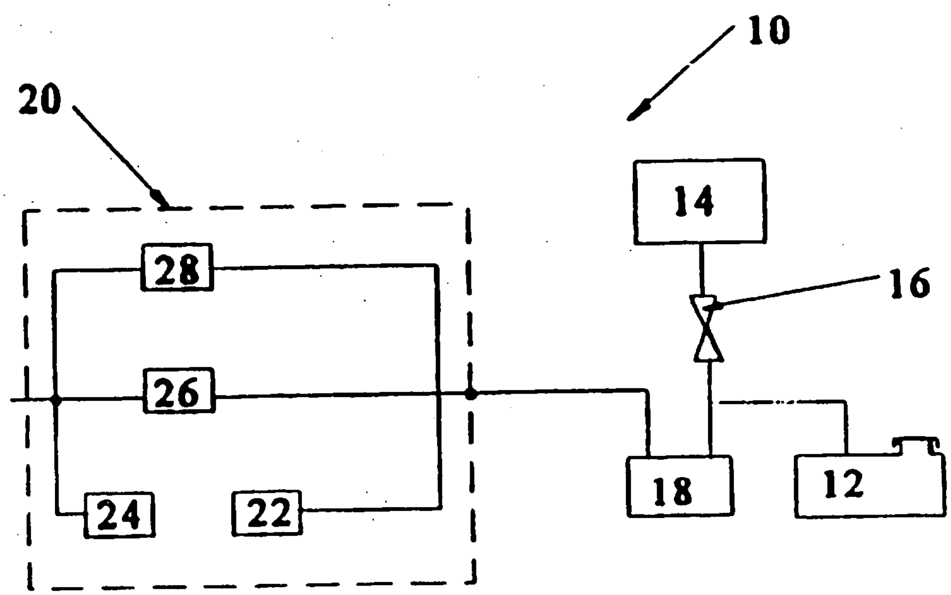
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *with amended claims*

Date of publication of the amended claims: 11 October 2001

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INTEGRATED PRESSURE MANAGEMENT SYSTEM FOR A FUEL SYSTEM



WO 01/38716 A1

(57) Abstract: An integrated pressure management system (20) manages pressure and detects leaks in a fuel system. The integrated pressure management system also performs a leak diagnostic for the head space in a fuel tank (12), a canister (18) that collects

AMENDED CLAIMS

[received by the International Bureau on 15 May 2001 (15.05.01); new claims 19-76 added; remaining claims unchanged (12 pages)]

15. The integrated pressure management apparatus according to claim 14, further comprising:

a ferrous armature secured to the valve, the ferrous armature being displaced in the displacement direction by the ferrous core.

16. A method of using fluid volume variations for leak detection, the method comprising: an actuator displacing the device.

17. The leak detection apparatus according to claim 2, wherein the actuator includes a solenoid.

18. The leak detection apparatus according to claim 3, wherein the detector includes a ferrous armature being disposed on the housing and signals] in response to displacement of the device in the chamber.

19. An integrated pressure management apparatus, comprising:

a housing defining an interior chamber, the housing including first and second ports communicating with the interior chamber;

a pressure operable device separating the chamber into a first portion and a second portion, the first portion communicating with the first port, the second portion communicating with the second port, the pressure operable device permitting fluid communication between the first and second ports in a first configuration and preventing fluid communication between the first and second ports in a second configuration;

a signal chamber in fluid communication with the first portion of the interior chamber, the pressure operable device further separating the signal chamber from the second pc: .ion of the interior chamber; and

a passageway through the housing, the passageway providing the fluid communication between the first portion of the interior chamber and the signal chamber.

20. The integrated pressure management apparatus according to claim 19, further comprising:

a solenoid displacing the pressure operable device from the first configuration to the second configuration.

21. The integrated pressure management apparatus according to claim 20, wherein the passageway is defined at least in part by a void between the housing and the solenoid.

22. The integrated pressure management apparatus according to claim 19, wherein the passageway includes an opening generally confronting the first port.

23. The integrated pressure management apparatus according to claim 19, wherein the pressure operable device includes a diaphragm separating the signal chamber and the second portion of the interior chamber.

24. The integrated pressure management apparatus according to claim 23, wherein the diaphragm includes a protrusion, and the passageway penetrates the protrusion.

25. The integrated pressure management apparatus according to claim 19, wherein the housing is an assembly of a minimum number of components with seals there between such that a number of possible leak points with respect to the interior chamber is minimized.

26. The integrated pressure management apparatus according to claim 19, further comprising:

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the first portion of the interior chamber.

27. The integrated pressure management apparatus according to claim 19, wherein the switch is disposed within the housing.

28. The integrated pressure management apparatus according to claim 27, wherein the switch is generally enclosed by the signal chamber.

29. A housing for an integrated pressure management apparatus, the housing comprising:
an integral homogenous primary body partially defining an interior chamber;
first and second ports communicating with the interior chamber;
a component opening facilitating installation of a pressure operable device into the interior chamber, the pressure operable device separating the interior chamber into a first portion and a second portion, the first portion communicating with the first port, the second portion communicating with the second port, the pressure operable device permitting fluid communication between the first and second ports in a first configuration and preventing fluid communication between the first and second ports in a second configuration; and
a secondary body attachable to the primary body and occluding the component installation opening.

30. The housing according to claim 29, wherein the primary body and the secondary body exclusively enclose the interior chamber having the first and second ports.

31. The housing according to claim 29, further comprising:
a seal member interposed between the primary body and the secondary body, the seal member preventing leakage with respect to the interior chamber.

32. The housing according to claim 29, wherein the pressure operable device includes a diaphragm sealingly interposed between the primary body and the secondary body, the diaphragm separating a signal chamber in fluid communication with the first portion of the interior chamber from the second portion of the interior chamber.

33. The housing according to claim 32, further comprising:
a passageway providing the fluid communication between the first portion of the interior chamber and the signal chamber.

34. The integrated pressure management apparatus according to claim 33, wherein the passageway includes an opening generally confronting the first port.

35. The housing according to claim 29, wherein a volume occupied by the attached primary and secondary bodies is minimized.

36. The housing according to claim 29, further comprising:

a plurality of electrical connections interconnected with a switch disposed in the interior chamber, the switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the first portion of the interior chamber.

37. The housing according to claim 29, wherein the primary body includes a first set of connection features and the secondary body includes a second set of connection features, the first and second set of connection features being interengaged to retain the secondary body with respect to the primary body.

38. The housing according to claim 37, wherein the first and second sets of connection features include unidirectional snap fixtures

39.. The housing according to claim 29, further comprising:

an aperture through which the first and second ports communicate in the first configuration, and the pressure operable device includes a poppet occluding the aperture in the second configuration.

40. The housing according to claim 29, wherein the component opening also facilitates installation of a solenoid into the interior chamber, the solenoid displacing the device from the first configuration to the second configuration.

41. The housing according to claim 40, wherein the solenoid includes a stator extending transversely with respect to a displacement direction of the pressure operable device between the first and second configurations.

42. The housing according to claim 40, further comprising:

a passageway providing fluid communication between the first portion of the interior chamber and a signal chamber, the signal chamber is separated from the second portion of the interior chamber by the pressure operable device, and the passageway is defined at least in part by a void between the housing and the solenoid.

43. An integrated pressure management apparatus for a vehicle having an internal combustion engine, the integrated pressure management apparatus comprising:

a housing defining an interior chamber, the housing including first and second ports communicating with the interior chamber;

a pressure operable device separating the chamber into a first portion and a second portion, the first portion communicating with the first port, the second portion communicating with the second port, the pressure operable device permitting fluid communication between the first and second ports in a first configuration and preventing fluid communication between the first and second ports in a second configuration;

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the first portion of the interior chamber; and

a solenoid adapted for displacing the device from the first configuration to the second configuration during engine operation and thereby providing a performance diagnostic of the switch.

44. A volatile fuel vapor purge system for an internal combustion engine, the volatile fuel vapor purge system comprising:

a fuel tank having a headspace;

an intake manifold in fluid communication with the headspace;

a charcoal canister in fluid communication with the headspace;

a purge valve having a first side in fluid communication with the intake manifold and having a second side in fluid communication with charcoal canister and with the headspace; and

an integrated pressure management apparatus including:

a housing having an interior chamber in fluid communication with the charcoal canister;

a pressure operable device separating the interior chamber into a first portion and a second portion, the first portion communicating with the charcoal canister, the second portion communicating with a vent port, the pressure operable device permitting fluid communication between the charcoal canister and the vent port in a first configuration and preventing fluid communication between the charcoal canister and the vent port in a second configuration; and

a solenoid adapted for displacing the device from the first configuration to the second configuration during engine operation and thereby providing a performance diagnostic of the purge valve.

45. The volatile fuel vapor purge system according to claim 44, wherein the integrated pressure management apparatus further includes:

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the charcoal canister.

46. The volatile fuel vapor purge system according to claim 45, wherein the solenoid is adapted for displacing the device from the first configuration to the second configuration during engine operation and thereby providing a performance diagnostic of the switch.

47. A method of providing a performance diagnostic of a purge valve connecting a charcoal canister to an intake manifold of an internal combustion engine, the method comprising:

providing an integrated pressure management system including:

a housing having an interior chamber in fluid communication with the charcoal canister;

a pressure operable device separating the interior chamber into a first portion and a second portion, the first portion communicating with the charcoal canister, the second portion communicating with a vent port, the pressure operable device permitting fluid communication between the charcoal canister and the vent port in a first configuration and

preventing fluid communication between the charcoal canister and the vent port in a second configuration;

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the charcoal canister; and

a solenoid adapted for displacing the pressure operable device from the first configuration to the second configuration;

actuating the solenoid during engine operation to displace the pressure operable device from the first configuration to the second configuration;

evaluating purge valve performance.

48. The method according to claim 47, further comprising:

evaluating switch performance.

49. A fuel system for supplying fuel to an internal combustion engine of a vehicle, the fuel system comprising:

a fuel tank having a headspace;

an intake manifold in fluid communication with the headspace;

a charcoal canister in fluid communication with the headspace;

a purge valve having a first side in fluid communication with the intake manifold and having a second side in fluid communication with charcoal canister and with the headspace; and

an integrated pressure management system including:

a housing connected to the charcoal canister and defining an interior chamber;

a pressure operable device separating the chamber into a first portion and a second portion, the first portion communicating with the charcoal canister, the second portion communicating with a vent port, the pressure operable device permitting fluid communication between the charcoal canister and the vent port in a first configuration and preventing fluid communication between the charcoal canister and the vent port in a second configuration; and

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the charcoal canister.

50. The fuel system according to claim 49, wherein the housing defines an aperture through which the charcoal canister and the vent port communicate in the first configuration, and the pressure operable device includes a poppet occluding the aperture in the second configuration.

51. The fuel system according to claim 49, wherein the housing further defines a signal chamber in fluid communication with the charcoal canister, and the pressure operable device further separates the signal chamber from the second portion of the interior chamber.

52. The fuel system according to claim 49, further comprising:

a minimum number of fluid communication connections.

53. The fuel system according to claim 49, wherein the pressure operable device comprises:

a poppet preventing fluid communication between the charcoal canister and the vent port in the second configuration;

a spring biasing the poppet toward the second configuration; and

a diaphragm separating the second portion of the interior chamber from a signal chamber in fluid communication with the charcoal canister.

54. The fuel system according to claim 53, wherein a negative pressure below the first pressure level displaces the poppet against the spring bias to the first configuration.

55. The fuel system according to claim 53, wherein a positive pressure above a second pressure level in the signal chamber displaces the diaphragm and the poppet against the spring bias to the first configuration.

56. The fuel system according to claim 49, further comprising:

an engine control unit operatively connected to the purge valve; and

a plurality of electrical connections fixed to the housing and adapted to electrically interconnect the switch with the engine control unit.

57. The fuel system according to claim 56, further comprising:

a control circuit disposed in the housing and electrically interconnecting the switch and the plurality of electrical connections.

58. The fuel system according to claim 49, further comprising:

a solenoid displacing the device from the first configuration to the second configuration.

59. The fuel system according to claim 58, wherein the solenoid includes a stator extending transversely with respect to a displacement direction of the device between the first and second configurations.

60. The fuel system according to claim 58, wherein the charcoal canister communicates with a signal chamber via a passage defined at least in part by a void between the housing and the solenoid.

61. The fuel system according to claim 49, further comprising:

a contiguous connection between the charcoal canister and the housing.

62. The fuel system according to claim 61, wherein the contiguous connection is selected from a group consisting of a bayonet connection, a threaded connection, and an interlocking sliding connection.

63. The fuel system according to claim 49, further comprising:

a remote connection extending between the charcoal canister and the housing spaced from the charcoal canister.

64. The fuel system according to claim 63, wherein the remote connection is selected from a group consisting of a rigid pipe and a flexible pipe.

65. A fuel system, comprising:

a leak detector sensing negative pressure at a first pressure level in a headspace of a fuel tank, a charcoal canister, and fluid conduits interconnecting the fuel tank and charcoal canister; and

a pressure operable device operatively connected to the leak detector, the pressure operable device relieving negative pressure below the first pressure level and relieving positive pressure above a second pressure level.

66. A method of managing pressure in a fuel system including a fuel tank, a charcoal canister, and fluid conduits interconnecting the fuel tank and charcoal canister, the method comprising:

providing an integrated assembly including a switch actuated in response to the pressure and a valve actuated to relieve the pressure; and

signaling with the switch a negative pressure at a first pressure level.

67. The method according to claim 66, further comprising:

actuating the valve to relieve negative pressure below the first pressure level.

68. The method according to claim 66, further comprising:

actuating the valve to relieve positive pressure above a second pressure level.

69. A method of calibrating an integrated pressure management apparatus, the method comprising:

providing a chamber having an interior volume varying in response to fluid pressure in the chamber, the chamber including a diaphragm displaceable between a first configuration in response to fluid pressure above a certain pressure level and a second configuration in response to fluid pressure below the certain pressure level;

providing a resilient element applying a force biasing the diaphragm toward the first configuration;

providing a switch actuated by the diaphragm in the second configuration;

connecting the chamber to a pressure source at the certain pressure level; and

adjusting the biasing force such that the switch is actuated at the certain pressure level.

70. The method of calibrating according to claim 69, further comprising:
providing an adjuster contiguously engaging the resilient element.

71. The method of calibrating according to claim 70, wherein the adjusting includes operating the adjuster to modify the biasing force.

72. The method of calibrating according to claim 70, wherein the providing an adjuster includes providing a calibrating screw threadably mounted with respect to the chamber, and the adjusting includes turning the calibrating screw.

73. The method of calibrating according to claim 72, wherein the providing a resilient element includes providing a leaf spring having a first end fixed with respect to the chamber and a second end contiguously engaging the diaphragm, and the adjusting includes turning the calibrating screw in contiguous engagement with an intermediate portion of the leaf spring between the first and second ends.

74, The method of calibrating according to claim 72, wherein the providing a resilient element includes providing a leaf spring having a first end fixed with respect to the housing and the calibrating screw connecting a second end of the leaf spring with respect to the chamber, and the adjusting includes turning the calibrating screw to adjust spacing between the first and second ends.

75. The method of calibrating according to claim 69, further comprising:
iterating the connecting the chamber to the pressure source and the adjusting the biasing force until the switch is actuated at the certain pressure level.

76. The method of calibrating according to claim 75, further comprising:

disconnecting the chamber from the pressure source between iterations of the adjusting the biasing force.